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FILAMENT-REINFORCED COMPOSITE ABRASIVE ARTICLES

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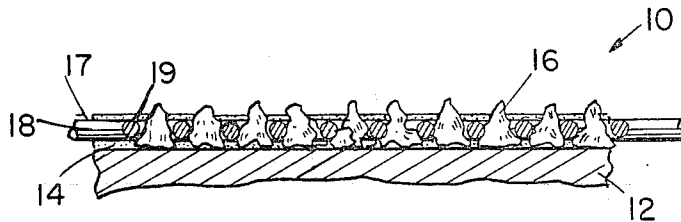


Fig. 1

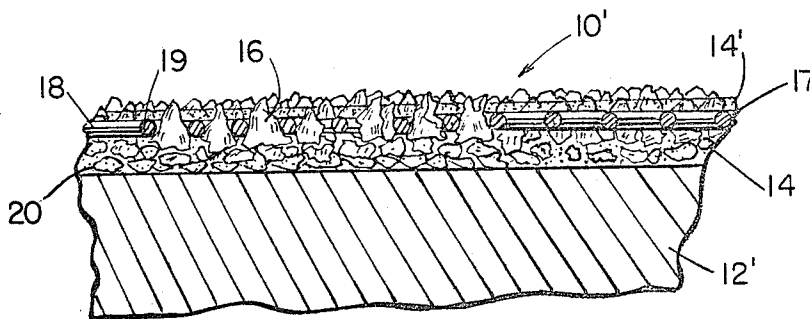


Fig. 2

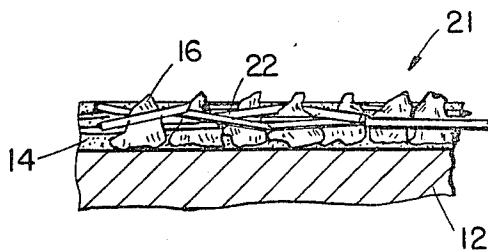


Fig. 3

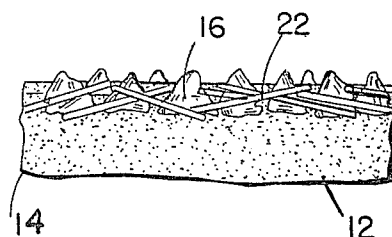


Fig. 4

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FILAMENT-REINFORCED COMPOSITE ABRASIVE ARTICLES

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9 Claims. (Cl. 51-298)

This invention relates to an article of manufacture made of a plurality of bonded components and is a continuation-in-part of my copending application Ser. No. 477,467 filed December 24, 1954 now abandoned.

It is a primary object of this invention to provide a new and improved article of manufacture made of a plurality of components which are bonded together into an integral structure with certain of the components serving to retain others in position.

Another object is to provide an improved article of manufacture made of a plurality of small particles of matter such as hard or abrasive bits which are retained together in an adhesive bonding material and a matte of fibers or filaments which are either tandemly arranged or provided as a woven structure and serve to enhance and improve the retention of said particles together.

Another object is to provide an improved article of manufacture made of a multitude of small particles or bits of abrasive material which are held in an adhesive or resinous binder forming a unitary structure which binder also retains a plurality of fibers or filaments arranged so as to enhance the strength of the structure and further retain the particles or bits in relation to each other and to a base member.

Another object is to provide an improved structure in an abrasive member having a plurality of abrasive bits or particles provided therein for machining or abrading a surface which particles are retained from loosening and removal not only by an adhesive, resinous binder but also by a plurality of filaments or fibers.

Another object is to provide a new and improved structure in an abrasive cloth.

Another object is to provide an improved structure in a cutting tool such as an abrasive wheel.

Another object is to provide an improved composite article of manufacture made of a fiber reinforced plastic and a plurality of bits or particles which are integrally secured thereto.

Another object is to provide an improved article of manufacture having substantially high resistance to surface wear and abrasion.

The invention also consists of certain new and original features of construction and a combination of parts hereinafter set forth as claimed.

The nature of the invention, as to its objects and advantages, the mode of its operation and the manner of its organization, may be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof which shows a fragment or portion of the article of manufacture comprising this invention.

FIG. 1 is a cross sectional view of an article of manufacture embodying the present invention.

FIG. 2 is a cross sectional view of another modified form of construction.

FIG. 3 is a cross sectional view of another modified form of construction.

FIG. 4 is a cross sectional view of yet another modified form of the invention.

In FIG. 1 is shown an article of manufacture made of a plurality of components and referred to by the general notation 10. The article 10 is shown as having a

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base 12 against which are secured a multitude of particles, chips or bits 16 which are retained by a layer 14 of adhesive material such as a plastic binder or resin coating or forming a portion of the base 12. The particles 16 may be of any suitable shape and possess any predetermined physical characteristic depending on the intended use of the article 10. For example, if the article 10 is to be utilized for abrading purposes, the particles 16 may comprise chips or crystals of abrasive material such as any suitable cutting grit. The particles 16 may comprise such materials as silicon carbide, tungsten carbide, diamond particles or dust, so called Carborundum or even crystals of sand or other abrasive material. The conventional abrasive cloth or paper containing such abrasive bits generally comprises in addition to the cloth or paper base, an adhesive provided as a thin coating or layer on the surface thereof and the particles or bits secured against or embedded in said adhesive. As such, the particles frequently are easily torn off or otherwise removed from the base during use of the material.

To improve the retention of the bits or particles 16 in the binder 14 and against the base 12, I provide a plurality of filaments or fibers which are adhesively bonded to the assembly 10 by means of the adhesive layer 14 and also preferably to those of the bits or particle 16 which they make surface contact with. In FIG. 1, the filaments 18 are shown as comprising a mesh-like array 17 of crossed filaments consisting of longitudinal filaments of fibers 18 and lateral filaments or fibers 19 woven into a cloth or provided as a matte through the openings of which protrude portions of each of the bits 16. However a random array of unjoined filaments, fibers, wires or whiskers may also be provided which criss-cross throughout the resinous binding material 14 with at least one element making contact with each of the bits or particles 16 and adhesively bonded thereto so as to serve as a means for anchoring the bit with greater tenacity within or against the binding layer for material or resin such as an epoxy, polyester, polyamide, polycarbonate, urea, or any of the known synthetic plastic materials having the desired physical and chemical characteristics. As stated the adhesive layer 14 may also comprise a portion of the base as in FIG. 3 or all of the base 12 as in FIG. 4 wherein the adhesive layer is identified as 12' or may be impregnated therein depending on the exact product specification and use. If the base 12 is a flexible cloth of woven or non woven characteristic, the binding plastic 14 may extend not only substantially covering the particles 16 but also through and through the cloth base 12. As such, the resin 14 may serve to also reinforce and/or rigidize the filaments, fibers or threads of which the base 12 is composed.

The base 12, as stated, may also comprise part (FIG. 3) or all of the resinous material 14 (see FIG. 4 wherein the resinous material is identified by numeral 12'') or a rigid material such as metal, ceramic or plastic other than that of which the adhesive binder 14 is made. As such the article 10 may comprise a rigid abrasive or abrading tool or a portion of a structure utilized for resisting abrasion, heat oxidation or other forms of corrosion and wear.

If the particles or bits 16 are made of a material such as tungsten carbide silicon carbide, etc. which may be easily plated by electro-deposition, flame-plating or other means, they may be plated with chromium carbides, such as tungsten carbide, or other material to improve their resistance to wear and abrasion. For example a hard chromium coating or plating on such particles will serve as a surface hardening means and a dry lubricant so that the particles will encounter less frictional forces during

the movement of the surface 11 of the composite article 10 against another surface, thereby enhancing the wear resistance characteristics of the article. The particles may be so plated prior to or after adhesive bonding to the surface of 12 after which a further layer of the binding plastic 14 may be applied thereover to a depth which includes contact with or encapsulation of the cloth 17 or array of filaments, fibers, threads or whiskers 18 and 19.

If the filaments 17 are provided as a woven or otherwise formed cloth or mesh it will act as a net for holding all the particles in place and if the openings in said net are of correct size they will permit portions of the particles to penetrate therethrough to provide an abrasive or abrading resistant surface 11.

The elongated reinforcing elements 18, as stated, may be provided in the form of a net or woven cloth, as a matte or loosely held together filaments or in a random array criss crossing the particles 16 throughout the binder layer 14. If provided as a cloth or net they may comprise woven synthetic or natural fibers of any suitable plastic, glass filaments, ceramic fibers or metal elements such as wires, rods or the like. The filaments or elements 18 and 19 may also comprise single elongated crystals of metal such as metal whiskers, the tensile strength of many of which are known to exceed that of most known materials. If such metal whisker elements are provided, they may be supplied as a matte of non-connected elements compressed into the binder layer 14, as a random mixture of such whisker elements pre-mixed with the adhesive or resinous material or as a matte of metal whiskers which is formed by compressing a plurality of aligned or randomly disposed single crystals of metal and resistance welding those portions of each whisker or crystal which cross portions of other whiskers or crystals by applying sufficient electrical potential between the platens or rollers between which said matte is so compressed. Such a resistance whelded matte will serve not only to retain the particles 16 in place but also to substantially enhance the strength of the assembly 10 in all directions.

It is noted that the binder material 14 in which the filaments 18, 19 and particles 16 are embedded in coacting array may comprise other than resinous materials, such as ceramic or metal provided originally in the powdered or particle state and sintered or otherwise solidified around the bits and filament array.

The improved composite structure or article illustrated in the drawing may be fabricated in a number of manners. For example, a first coating or layer of adhesive may be applied to the base member 12 upon which is disposed by gravity or blown a multitude of the particles 16 which are retained by said adhesive. The adhesive may be allowed to dry or solidify or retained in a molten or tacky condition while the individual filaments, whiskers or cloth netting 17 is brought to bear against the particles so that the particles project through the openings therein as illustrated. Further adhesive or resin may then be applied to increase the depth of the coating and to adhesively bond the individual elements of the matte, random array of filaments or cloth to the individual particles or chips 16. In another method, the filaments 18 and 19 may be provided as a matte, cloth or random array in a layer of resinous material provided on the base member 12 and the particles or bits 16 may be blown, fed by gravity and/or compressively pressed by means of rollers or a platen into the resinous layer and into surface engagement with the individual filaments, fibers or whisker elements 18 and 19.

In a further method, the bits 16 as well as short lengths of filaments, fibers or whiskers may be premixed with a predetermined quantity of resin or adhesive material and applied by flowing, roller-coating, extrusion coating or other means to the surface of the base member 12 in such a manner as to provide a random array of particles and elongated elements coacting within the binder layer

whereby the retention of the bit elements is enhanced by the elongated elements. Such a mixture may also be cast or molded into various shapes depending on the end use, in such a density that the elongated elements or filaments cooperate with the binder or resin 14 in retaining the bits in place, and the bits 16 in turn cooperate in retaining the elongated elements in position.

In a further method for producing an article having the components illustrated in the drawing, a non-woven matte or cloth of woven filaments, threads or fibers may be provided and saturated with an adhesive or resinous material. The bits or particles 16 may thereafter be compressed or otherwise deposited against the adhesive material saturating the cloth or surrounding the individual filaments or fibers thereof while still in a molten or tacky condition. The composite article so formed may be utilized per se after solidification of the plastic or may be compressively engaged against a base member or support such as 12 prior to solidification of the plastic or after solidification thereof by the application of a further layer or coating of adhesive or resinous material to one surface of said particle adhered structure or to the surface of the base member 12.

In another method of producing an article of the type provided in the drawing, the particles or abrasive bits 16 may be deposited in the binder 14 on the base 12 and the filaments or threads 18 or 19 forcibly secured thereof. One means for forcibly securing said filament or thread members within the resin and against the base and bits, is to provide it as an elongated thread or filament of substantial length, provide the base 12 as a rigid element or secured against a rigid element or cylindrical or other elongated shape and winding said filament against or around the base 12 in a manner to provide it in spaced-apart array as shown. Winding may be effected to provide said filament in one direction or in the two directions illustrated to tensionally draw the filament and particles against the base and may be effected with the filament or thread coated with adhesive in a state prior to setting.

The improved structure in a coated, abrasive bit hereinabove described, may be fabricated in a number of manners. For example, the bits may be charged into a so-called rotary hopper and caused to flow as a steady stream from a first level in the hopper to the lower end thereof by rotation of the hopper. As the bits freely fall through space, a coating application means such as flame spraying equipment of the plasma-arc type may direct a stream of heated particles or vapor of the material to be coated against the falling particles for a sufficient period of time so that a coating of substantially equal thickness develops on substantially all of the particles. The coating may comprise such hard surfacing materials as tungsten carbide, boron carbide, tungsten metal or other extremely hard metal or compound. A face on which the coated bit is fabricated may comprise a softer material having the desired characteristics such as a silicate, quartz, oxide such as aluminum oxide, or perhaps even metal of predetermined shape. For example, it is known that the metal molybdenum is capable of withstanding temperatures in excess of 4,500° F. Pre-shaped small cutting members made of molybdenum and flame coated with a hard material such as tungsten carbide may be used for machining or grinding purposes and in an environment or condition whereby high temperatures exist during machining without destruction of the cutting tool or particles.

The free-falling particle or particles plating or coating method described in the hereinabove paragraph may include preheating the particles or articles to be coated by means of a second flame or plasma-jet or jets directed thereagainst prior to free-fall through space to facilitate coating since the particles will only be heated during the short interval they fall through the coating flame or jet.

In another method, a plurality of particles may be disposed against a base member preferably made of a high

temperature resistant metal such as molybdenum or ceramic or coated with a ceramic material such as tungsten carbide and, while so disposed, may be flame coated by directing a coating jet or flame such as a plasma arc against the upper surfaces of the particles. The flame sprayed material will thus be applied as a uniform coating not only to the exposed surfaces of the bits or particles but also to the surrounding areas of the layer of bonding material, (i.e. sintered powdered metal, fibers, combinations of metal and fibers or whiskers, resin, etc.). Depending on the nature of the coating material, the resulting structure may be provided with varying degrees of oxidation resistance, hardness, lubrication, etc.

Coating of various materials such as molybdenum, tungsten, tantalum, columbium, zirconium, titanium, etc. or alloys, oxides, nitrides or other compositions containing these high temperature metals may be applied by means such as described above not only to enhance the physical characteristics of abrasive bits, metal powder particles, etc. but may also be applied to short single crystals of metal such as metal whiskers to enhance their physical characteristics and enhance their resistance to heat oxidation and other chemical attack. Alternate coatings of the same or different metals, alloys, oxides, nitrides, cermets, etc. or combinations of these materials may be applied as described to predetermined thicknesses to cooperate in producing particles, whiskers or composite articles as described having predetermined physical and chemical characteristics.

Whereas in FIG. 1, the individual particles or abrasive bits 16 are shown immediately adjacent the surface 13 of the base member 12 and are preferably initially held thereagainst by means of the cloth or webbing 17, in FIG. 2 a modified structure is shown in which the abrasive bits or particles are applied as a plurality of layers distributed throughout the binding layer 14 and in which only the upper layer of said particles 16 penetrate or push through the openings in the cloth or netting 17. Thus there are provided a plurality of bits or particles 20 underneath those bits 16 which protrude outward from the surface of the member 10'. The lower layer or layers 20 of particles may serve a number of functions including that of substantially enhancing the strength of the bonding layer 14 and providing means for replenishing particles should the article 10' be subject to abrasion or wear. It is also noted in FIG. 2 that the adhesive or binding material 14 is shown extending substantially above the upper surface of the netting or cloth 17, at least to a greater degree than illustrated in FIG. 1. In both the embodiments illustrated in FIGS. 1 and 2, it is noted that the individual particles or bits 16 are bonded and held not only by the adhesive layer 14 but also the individual filaments or threads of the netting or cloth 17 to which they are bonded.

In FIG. 3 preferred embodiment of the invention is illustrated in which the woven cloth or netting 17 of FIGS. 1 and 2 has been replaced by a plurality of short, randomly distributed fibers or filaments 22 which are disposed within the adhesive layer 14 and are individually bonded not only to the individual bits 16 but to each other at points where they cross. The combined article 21 thus provides a bit covered base 12' held in a binder layer 14 and further retained together by means of filaments or fibers 22 of any suitable synthetic plastic, ceramic or glass materials. It is briefly noted that the filament elements 22 may also comprise metal wires or whiskers randomly distributed throughout the bonding layer 14 though preferably extending substantially parallel to the surface 13' of the base 12'.

FIG. 4 illustrates a construction similar to that described with respect to FIG. 3 except that the entire base 12 is formed of a resinous material 12'' which is similar to the material of layer 14 of FIG. 3. The individual bits 16 and filamentary bodies 22 of FIG. 4 are

similar in every respect to their respective counterparts 16 and 22 of FIG. 3.

I claim:

1. A composite article of manufacture comprising in combination;
 - (a) a solid supporting base member,
 - (b) a layer of particles defining abrading bits randomly placed on the surface of said base member to define a roughened surface,
 - (c) a plurality of individual disconnected elongated filamentary bodies interposed between the particles of said layer to define a random array of individual crossing rod like filamentary bodies forming a reinforcing matrix for retaining the particles of said layer fixed relative to one another regardless of the sizing or spacing thereof,
 - (d) and a layer of bonding material for bonding said particles and filamentary bodies to said base member and to each other to form said composite article whereby said filamentary bodies and base portion only of said particles are embedded in said layer of bonding material.
2. An article of manufacture comprising in combination;
 - (a) a solid supporting base substratum,
 - (b) a layer of bonding material adhesively attached to said supporting base substratum,
 - (c) a plurality of randomly dispersed hard particles of abrasive elements embedded in said layer of bonding material, said particles having a portion thereof extending beyond said layer of bonding material,
 - (d) and a plurality of discrete elongated filamentary bodies randomly dispersed and crossing each other between the particles of said abrasive elements within the layer of said bonding material for reinforcing said article.
3. The invention as defined in claim 2 wherein said supporting base substratum is formed of a flexible material.
4. The invention as defined in claim 2 wherein said filamentary bodies comprise individual rod-shaped elements of glass.
5. The invention as defined in claim 2 wherein said filamentary bodies comprise metallic whiskers.
6. The invention as defined in claim 2 wherein said base substratum is defined by a substratum portion of said layer of bonding material.
7. A method of forming an abrasive article of manufacture comprising the steps of first depositing a coating of adhesive material against the surface of a supporting base member, next randomly depositing a plurality of bits of abrasive material against said adhesive coating in a manner causing the bits to become bonded thereto, randomly locating a plurality of discrete and disconnected elongated filamentary elements in the spaces between said particles and throughout said adhesive material to serve as means for reinforcing and retaining said abrasive particles, and allowing said adhesive material to solidify into a unitary structure reinforced by said filamentary elements.
8. A method of producing an abrasive article of manufacture comprising the steps of coating a base member with a mixture comprising an adhesive material having a plurality of short reinforcing discrete, individual and disconnected filament elements disposed randomly throughout said material and providing within said coating a plurality of bits of abrasive material, allowing said adhesive material to solidify into a unitary structure to bond said bits and said filaments and to said base member in contact with each other in a manner whereby said filaments reinforce said adhesive material and serve as means for retaining said abrasive bits therein.
9. A composite article of manufacture comprising in combination a solid supporting base member, a layer of particles defining abrading bits randomly placed on the

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surface of said base member to define a roughened surface, a plurality of individually disconnected elongated filamentary bodies interposed between the particles of said layer to define a random array of individual cross-
 5 ing filamentary bodies to form a reinforcing matrix for retaining the particles of said layer fixed relative to one another regardless of the sizing or spacing thereof, and a layer of bonding material for bonding said particles and matrix to said base member and to each other to
 10 form said composite article whereby said filamentary bodies and base portion only of said particles are embedded in said layer of bonding material, said abrasive bits having a plurality of material cutting edges, said bit having a first core portion made of a first material which
 15 has a first degree of hardness, and a coating of a second material having a hardness and wear resistance substan-

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tially greater than that of said first material of the core covering said core portion.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,276,852

October 4, 1966

Jerome H. Lemelson

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 22, "tandemly" should read -- randomly --.
Column 2, line 25, "particle" should read -- particles --; line 29, "of" should read -- or --; line 38, "for" should read -- or --; line 48, "only substantially covering" should read -- only to substantially cover --. Column 3, line 29, "compessed" should read -- compressed --; line 38, "whelded" should read -- welded --. Column 4, line 54, before "other" insert -- any --. Column 5, line 55, before "preferred" insert -- a --.

Signed and sealed this 12th day of August 1969.

SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.

Commissioner of Patents